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INVENTION TITLE

Structural Component made of fiber-reinforced Thermoplastic Material

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DESCRIPTION

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Deleted: The invention is related to a structural component made of long-fibre reinforced thermoplastic material with integrated continuous fibre reinforcements according to the generic term of claim 1. ¶

Background

[Para 1] The invention is related to a structural component made of long- fiber reinforced thermoplastic material with integrated continuous- fiber reinforcements.

[Para 2] Known structural components of this kind in most instances comprise plane continuous fiber reinforcements, e.g., with semi-finished fabric products or with a sandwich structure, which, however, are very limited with respect to possible shapings and applications. Structural components with integrated continuous fiber strands have also become known. International patent application publication WO99/52703 (see also U.S. Pat. No. 6821613) discloses a structural component with a shape forming long- fiber reinforced thermoplastic matrix and with an integrated load-bearing structure made of continuous fiber strands. In this, the continuous fiber strands are joined to one another by plane junction points. This, however, solely results in simple, plane load-bearing structures and not in three-dimensionally shaped continuous fiber reinforcement structures, and therefore does not provide the optimum absorption and transmission of three-dimensionally attacking loads and forces.

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[Para 3] It would thus be very desirable if a way could be found to overcome the disadvantages and limitations of the known structural components and to create a structural component with a light continuous fiber reinforcement structure, and if this could make possible a three-dimensional support and transmission of loads and forces to be absorbed, with an optimum adaptation to the force gradients for a broad range of applications.

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Summary of the invention

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[Para 4] This objective is achieved in accordance with the invention by a structural component with an integrated three-dimensional intersection point, which is formed out of several individual, shaped continuous fiber (CF) - profiles in a long- fiber thermoplastic (LFT) - mass.

[Para 5] The dependent claims relate to advantageous further developments of the invention with respect to optimum three-dimensional design of the continuous fiber reinforcement structure and utilisability in a large number of applications with optimum mechanical characteristics for the absorption of loads in any direction. This results in light, easy-to-manufacture structural components, e.g., for means of transportation, vehicles and vehicle components with load-bearing functions.

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Description of the drawing

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[Para 6] The invention will be described with respect to a drawing in several figures:

- o Fig. 1a – a structural component according to the invention with a three-dimensional intersection point of several CF - profiles,
- o Fig. 1b, c - cross-sections through a three-dimensional intersection point in different views,
- o Fig. 2 - a further example of a three-dimensional intersection point with variable profile cross-sections,
- o Fig. 3a - an "X" - shaped intersection point,
- o Fig. 3b - a "T" - shaped intersection point,
- o Fig. 3c - an "L" - shaped intersection point,
- o Fig. 4 - a "T" or "X" - shaped moment load-lever structure,
- o Fig. 5 - an "L" - shaped moment load-lever structure,

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o Fig. 6 - examples of three-dimensional profile shapings,

o Fig. 7a, b - two different cross-sectional shapes of an CF - profile in a rib,

o Fig. 8a - an arrangement of several CF - profiles in a 2/3 rear seat back with three-dimensional intersection point,

o Fig. 8b - the LFT - shaping of the component with the integrated CF - profiles,

o Fig. 9 - a single seat back with three-dimensional intersection points,

o Fig. 10 - an arrangement of CF - profiles as seat shell or cabin floor,

o Fig. 11 - a car door structure, and

o Fig. 12 - an example of a two-shell component.

o Where possible, like elements have been designated with like reference designations.

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Detailed description

Deleted: The dependent claims relate to advantageous further developments of the invention with respect to optimum three-dimensional design of the continuous fibre reinforcement structure and utilisability in a large number of applications with optimum mechanical characteristics for the absorption of loads in any direction. This results in light, easy-to-manufacture structural components, e.g., for means of transportation, vehicles and vehicle components with load-bearing functions. ¶

[Para 7] Fig. 1a illustrates a portion of a structural component which, according to the invention, has a three-dimensionally developed (spatial) intersection point 50. The structural component comprises a shaping LFT - mass 6 (made of long- fiber reinforced thermoplastic) with a continuous fiber reinforcement comprising several individual, integrated CF - profiles 10. As will be discussed in more detail below, the CF profiles each have a defined shaping, and each is shaped corresponding to the forces and loads to be absorbed; each is individually precisely positioned within the structural component.

[Para 8] The three-dimensional intersection point 50 comprises an upper main plane H1 and a lower main plane H2, the two planes defining a vertical spacing v. The intersection point 50 is formed by (a) at least three CF - profiles, which run together, by which is meant that they intersect with one another at the intersection point, and (b) by the LFT - mass 6 joining all these profiles. In this, at least one CF - profile has to lie in the upper main plane H1 (here the profile 10.1) and one CF - profile in the lower main plane H2 (here the profile

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10.4). And between the CF - profiles of the upper and of the lower main plane at least one further CF - profile, here the profiles 10.2 and 10.3, with a vertical orientation (by which is meant that they have an extension in vertical direction), has to pass through, in order to absorb a moment M2. All CF - profiles are joined together at the intersection point by the LFT - mass 6 in a force transmitting manner through corresponding shapings 32 of the LFT - mass, that is to say, through suitable selections of the shapes of the CF - profiles and of the LFT - mass.

[Para 9] In the example of Fig. 1a the CF - profiles 10.1, 10.4 are located in a crimp 7 and the CF - profiles 10.2 and 10.3 in ribs 8. In this manner forces F, moments M and loads L, which act on a structural component in differing directions, are absorbed by the CF - profiles and transmitted to the three-dimensional intersection point 50. It is in particular possible to transmit moments at the intersection point from one profile pair to the other one. Here the CF - profiles 10.1 and 10.4 with the crimp 7 form a girder subject to bending and the profile pairs 10.2 and 10.3 in the rib structure 8 form a second girder subject to bending. Advantageously, for example the moments M1 and M2 are each able to be absorbed and each is able respectively to be transmitted elsewhere within the component. An essential advantage of this arrangement of the CF - profiles according to the invention at the three-dimensional intersection point is the fact that the intersection point consists of a single component and does not have to be assembled out of several components. As an example, this component may be manufactured by inserting the CF - profiles into an LFT - shaping tool (one after the other or together) and subsequently a molten LFT - mass is introduced in a single step, and the constituents are pressed in an LFT - press to become a one-part structural component.

[Para 10] A typical sequence of manufacture will now be described. First the CF - profile 10.1 is deposited in the lower main plane H2, then the CF - profiles 10.2 and 10.3 are

deposited in the vertical intermediate zone v and thereupon the CF - profile 10.4 is deposited in the upper main plane H1. Subsequently the molten LFT - mass 6 is placed on top and pressed together with the CF - profiles. It will be appreciated that for clarity of visual presentation, this Fig. 1a illustrates the component after it has been turned over, so that in the figure H1 lies at the bottom and H2 lies on top, and in this way the CF - profiles are well visible. The direction in which the CF - profiles 10 and the LFT - mass 6 are deposited, is indicated with an arrow 10,6.

[Para 11] Figs. 1b and 1c illustrate two sections through a second embodiment of a three-dimensional intersection point 50. In this second embodiment, there are two CF - profiles 10.3, 10.4 in the upper main plane H1, there is a CF - profile 10.1 in the lower main plane H2, and there is a CF - profile 10.2 in a rib 8 in the vertical zone v in between. The CF - profiles 10.1, 10.3, 10.4 lie in a crimp 7, which intersects with the rib 8. The position of the component here is illustrated in the manner it lies in the assembly tool (the LFT - tool).

[Para 12] Fig. 1b illustrates the cross-section through the crimp 7, (which absorbs the moment M1) and Fig. 1c illustrates the cross-section through the rib 8, (which absorbs the moment M2).

[Para 13] For the optimum force transmission of CF - profiles 10 on to the LFT - mass 6 and from an CF - profile (10.1) through the LFT - mass on to other CF - profiles (10.3, 10.4), the LFT - mass comprises bonding shapings 32. By the arrangement of the CF - profiles and the shapings 32 of the LFT - mass the required force transmission is produced at the three-dimensional intersection point 50.

[Para 14] Fig. 2 illustrates a third embodiment of a three-dimensional intersection point in a component, which is designed as a bent shell. The main planes H1 and H2 here form tangential planes at the intersection point 50. The vertical spacing between H1 and H2 is, in this embodiment, relatively small for reasons of limited space. In this embodiment the CF -

profile 10.2 (which intersects with the flat CF - profiles 10.1 and 10.3 in the zone v at the intersection point) is able to comprise a reduced height with, e.g., a square cross-section a. Despite having a reduced height v at the area of cross-section a, the CF - profile 10.2 in its extent leftward and rightward in Fig. 2 is able once again to change over into a flat, vertically oriented cross-section b.

[Para 15] As a general matter, it is important to appreciate that the CF - profiles in the v - zone comprise a vertical extension for the purpose of transmission of moments. Stated differently, the CF - profiles 10 in principle are able to comprise any three-dimensional shaping and position, selected to adapt to particular load conditions and force gradients.

[Para 16] Figs. 3a, b, c schematically illustrate various possible types of three-dimensional intersection points. Each structural component has to absorb and to transmit onwards several loads L, forces F and moments M, which attack at different points of the structural component and in differing directions. The three-dimensional intersection points 50 according to the invention are able to be, for example, designed as "X"-, "T"- or "L"-shaped, by means of corresponding arrangements of the CF - profiles. Thus, for example:

o Fig. 3a in this context illustrates an "X"-shaped intersection point with load absorptions at the points L1 to L4 and with force transmissions (designated "UB") at the intersection point 50.

o Fig. 3b illustrates a "T"-shaped intersection point with load absorptions at the points L1, L2, and L3 and with force transmissions at the intersection point.

o Fig. 3c illustrates an "L"-shaped intersection point with the load absorptions L1, L2, L3 and at the point L2 also with force transmissions at the intersection point.

[Para 17] Figs. 4 and 5 illustrate examples of moment - load lever structures, which are formed by the arrangement of the CF - profiles with the intersection point 50.

[Para 18] Fig. 4 illustrates a moment - load lever structure with a "T"- or "X"-shaped intersection point 50. With it a force +F is supported as a main load direction, and the load is absorbed by a CF - profile 10.2 as vertically oriented profile v, e.g., in a rib between two horizontal CF - profiles 10.1 in the lower main plane H2 and 10.3 in the upper main plane H1. The force F results in a moment M, which is supported by the CF - profiles 10.1, 10.3 in an appropriate shaping of the LFT - tool, e.g., in a crimp.

[Para 19] Fig. 5 illustrates an "L"-shaped moment - load lever structure, which as a main load direction supports forces +F, -F (i.e., in both directions). It once again contains a vertically oriented profile 10.2 in the zone v, which is supported by three CF - profiles, e.g., at a crimp and in the main planes: the CF - profile 10.1 in H2 and the CF - profiles 10.3 and 10.4 in H1. With this, the moments +M, -M resulting from the forces +F, -F are supported and transmitted onwards.

[Para 20] It will thus be appreciated that the shaping and arrangement of the CF - profiles may be selected to deal with the differing functions and requirements at different points of a CF - profile. They may comprise a three-dimensional shaping and for this purpose in longitudinal direction comprise a bend, a rotation, a twisting, a folding and/or a surface structuring and they may comprise varying, differing cross-sectional shapes.

[Para 21] Fig. 6 illustrates examples of possible shapings of CF - profiles:

- The CF - profile 10.1 manifests a roundish cross-section, which is flattened and spread out and in the spread-out area forms a large bonding surface to the surrounding LFT - mass (in the same manner as CF - profile 10.5 in this figure).
- The CF - profile 10.2 comprises a flat arc and is split in two at one end.
- The CF - profile 10.3 comprises a twist from a flat to a vertically oriented cross-section.
- The CF - profile 10.4 manifests a fold.

o The CF - profile 10.5 shows a surface that is structured and zig-zag-shaped, and in this way provides a greater surface area.

o The CF - profile 10.6 is bent into a "U"-shaped double rib. This could be utilised, e.g., in place of the two CF - profiles 10.2 and 10.3 in Fig. 1a.

[Para 22] The Figures 7a, 7b illustrate an example of a CF - profile 10, which over its length comprises differing cross-sectional shapes, the differing cross-sectional shapes being in adaptation to the forces to be transmitted and for the optimum bonding with the LFT - mass 6. The Figures in cross-sectional view illustrate a CF - profile 10a, 10b in a rib 8, e.g., corresponding to the profiles 10.2 or 10.3 of Fig. 8, at two different locations.

[Para 23] Fig. 7a illustrates a shaping 10a with a positioning shoulder 55 for fixing and holding the CF - profile in the required position. The shoulder 55 is especially helpful during pressing, when the liquid LFT - mass 6 is pressed into the rib. On top and underneath the CF - profile respectively comprises a thicker zone 56 as tensile - and compressive zones (in longitudinal fiber direction) for the transmission of moments. Located in between is a thinner thrust zone 57 with a correspondingly thicker adjacent LFT - layer 6 and with a large bonding surface area and a particularly strong interface joint. With this, the shear resistance is increased by the adjacent LFT - layer 6 with isotropic fiber distribution (while the strength transverse to the fiber orientation in the CF - profiles 10 here is lower).

[Para 24] The rib shown in Fig. 7a as just discussed, is shown again at another location in Fig. 7b. At this part of the rib, the profile cross-section 10b is selected corresponding to a force situation there: stretched, i.e., higher and narrower and without a positioning shoulder.

[Para 25] It is desirable that during manufacture, the CF-profiles be securely and accurately positioned and fixed. Thus during the pressing with the LFT - mass, further

positioning points 54 may be developed on the CF - profiles, which correspond to the shaping of the LFT - tool 31o (top, "o" standing for "over") and 31u (bottom, "u" standing for "under"). Here the positioning point 54 serves for the accurate positioning below in the rib 8. Positioning points can also be arranged suitably distributed in the longitudinal direction of the CF - profiles.

[Para 26] In an analogous manner, profile shapes of this kind may also be positioned and fixed on crimped walls, e.g. on the two side walls of a crimp 7 instead of the two CF - profiles (10.2., 10.3) in two separate ribs 8, as it is illustrated in the following example of Fig. 8.

[Para 27] Designs other than those shown in Figs. 7a, 7b may be devised. For example it is possible to design the cross-sections of CF - profiles as "L"- or "Z"-shaped, depending on the application.

[Para 28] Figs. 8a, b illustrate a complex structural component with a three-dimensional intersection point in the form of a two third (2/3) rear seat back 74 with a central seat belt connection 60 for the middle seat and a lock 58 and with several demanding load introductions for different load cases (crash loads). Fig. 8a in plan projection illustrates the arrangement of the CF - profiles in the component. Fig. 8b is a perspective view the LFT - mass 6 and shown within it the integrated CF - profiles 10.1 to 10.4. This example illustrates the load-optimised shaping of the CF - profiles themselves as well as the load-optimised arrangement of the CF-profiles to form a structure with a corresponding shaping of the LFT - mass 6 and with an optimum bonding strength between the CF - profiles carrying the main loads (with directed continuous fibers) and the complementing LFT - mass (with undirected long fibers).

[Para 29] Here four main load carrying points L1 to L4 result from:

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o the loads L1, L2 on the axle holders 59a, 59b, around which the rear seat back 74 is capable of being swivelled,

o the load L3 on the lock 58, for fixing the rear seat back in its normal position and

o the load L4 on the belt lock, namely a belt roller 60 for the central belt of the middle seat.

[Para 30] With this structural component the following loads (with the further loads L5 to L9) are provided for:

o front - and rear collision,

o securing of any goods loaded,

o belt anchoring, and

o head support / head rest anchoring.

[Para 31] For the receiving and transferring of all loads and forces the intersecting CF - profiles together with the joining force-transmitting shapings of the LFT - mass form a spatial, three-dimensional intersection structure 50. Here the CF - profiles respectively in pairs in the LFT - shapings form a moment-transmitting girder subject to bending:

o the CF - profiles 10.1 and 10.4 in a crimp 7 of the LFT - mass form a girder subject to bending between the loads L1 and L4

o the CF - profiles 10.2 and 10.3 in the ribs 8 of the LFT - mass form a girder subject to bending between the loads L2 and L3.

[Para 32] Through the three-dimensional intersection point 50, in this the load L4 on the belt roller 60 and also other loads, which act on the girder subject to bending 10.1 / 10.4, is also supported on the other girder subject to bending 10.2/ 10.3 (and vice-versa).

[Para 33] The main forces, namely loads L1 to L4, are received by means of force introduction points:

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o through shapings 22 and 32 of the CF - profile ends and of the LFT - mass for receiving the external forces with or without inserts 4;

o in doing so, the inserts 4 prior to the pressing operation are able to be inserted into the LFT - tool and then pressed together with the CF - profiles and the LFT mass;

o or else it is also possible to fit them into the component later on.

[Para 34] Here the CF - profile 10.1 comprises an arc-shaped widening 22 and an adapted widening 32.1 for receiving a metallic insert 4 at the axle bearing 59a. The other axle holder receptacle 59b is formed by shapings 22.2 of the CF - profiles 10.2 and 10.3 and by adapted joining shapings 32.2 of the LFT - mass. These profile ends 22.2 are bent over and in this manner anchored in the LFT - mass for the purpose of increasing the tensile strength. The lock 58 is bolted on to a lock plate on the CF - profile 10.3 and supported by the CF - profile 10.2. The belt roller 60 is supported by shapings 22 of the CF - profiles 10.1 and 10.4 and by LFT - shapings 32.

[Para 35] The smaller loads L8, L9 of head supports 61 here are absorbed through LFT - shapings 32. For reinforcement, however, it would also be possible to integrate an additional CF - profile 10.5 deposited transversely (in some zones oriented flat or vertically).

[Para 36] In the case of this component just discussed, the manufacturing steps include the following:

[Para 37] a depositing sequence of the CF - profiles into the LFT - tool is as follows:

o first the CF - profile 10.1 is deposited into the LFT-tool (in H2);

o thereafter the CF - profiles 10.2 and 10.3 are deposited into the LFT-tool;

o subsequently the CF - profile 10.4 is deposited into the LFT-tool (in H1).

[Para 38] Then the liquid LFT - mass 6 is introduced and the complete tool is pressed as a single shell and as a single part in a single step.

[Para 39] In Figs. 8a and 8b, the illustrated structural component is lying in the LFT - shaping tool upside down, i.e., in the figure H2 is at the bottom and H1 is on top. Stated differently, Fig. 8 illustrates the rear side of the rear seat back 74.

[Para 40] In this example also the three-dimensional profile shaping is evident in many variants.

[Para 41] The shapings in the structural component may comprise special shapings 22 for force transmissions and for the direct absorption of external loads, particularly, for the receiving of inserts 4 (mounting parts), at which external loads are introduced into the component. The shaping of the surrounding LFT - mass 6 is also selected to match the shaping of the CF - profiles 10. Shapings of force transfer points (of forces and moments) inside a component (e.g., from an CF - profile through the LFT - mass on to other CF - profiles) can be formed both as shapings 22 of the CF - profiles as well as shapings 32 of the LFT- mass.

[Para 42] To the extent possible, rather than employing abrupt steps in the interface between the CF-profiles and the LFT-mass, continuous and smooth transitions are employed.

[Para 43] Fig. 9 illustrates a single seat back 72 with a belt connection 60 and head supports 61, in the case of which similar loads and load cases occur as in the example of Fig. 8, here with the main loads being load L1 at the belt connection 60, and load L2 due to the weight of the passenger. All loads, however, have to be supported by the axle holders, which are capable of being fixed at 59b, and possibly also at 59a, around which the seat back is capable of being swivelled. In this, the swivel locking may be present on both sides (at both 59b and 59a) or frequently only on one side at 59b. In the latter case, a profile support formed out of CF - profiles between the lock 59b and the belt connection 60 has to be designed to be particularly strong with an enhanced stiffness against torsion. For this

purpose here a closed hollow profile cross-section can be formed (in analogy to Fig. 12), for example, with three CF - profiles 10.1, 10.2, 10.3 in a crimp 7 of the structural component 1 and thereupon a separate cover component 1.2 with an CF - profile 10.10 may be thermoplastically welded.

[Para 44] The profile support between the axle holders and the locks 59a and 59b here comprises the CF - profiles 10.4, 10.5, 10.6 in the main planes H1, H2 on a crimp 7. The profile support between the axle holder 59a and the belt connection (belt roller) 60 is curved and comprises two vertical CF - profiles 10.7, 10.8, e.g., in the side walls of a crimp 7. Here two three-dimensional intersection points 50 are formed on the axle holders 59a and 59b. In doing so, all CF - profiles are integrated into crimps here, wherein at the three-dimensional intersection points of the CF - profiles the crimps locally become ribs, so that there an intersection point between a rib 8 and a crimp 7 is always produced and so that all CF - profiles are capable of being deposited in a single step and the structural component 1 is able to be pressed in a single step and in a single piece. It goes without saying, that other arrangements of CF - profiles in ribs and in crimps are also able to be combined as per requirements.

[Para 45] Fig. 10 illustrates an arrangement of CF - profiles with a three-dimensional intersection point 50, which is designed as a seat shell 76 or as a cabin floor, e.g., of a lift cabin. In order here to implement a shell with a relatively small thickness, i.e., with a small vertical spacing v between the main planes H1, H2, in this case three vertical CF - profiles 10.2, 10.3, 10.4, are integrated into a rib structure, which intersect with two CF - profiles 10.1, 10.5 in the main planes H1, H2. At a free end L1 of a seat shell, the CF - profiles 10.1 und 10.5 may also run together and may be directly joined together there in a plane manner. This structure supports the loads L2 - L4 (and also the load L1).

[Para 46] Fig. 11 illustrates an example of a structural component, which forms a supporting structure of a car door 78 with integrated side crash protection. The CF - profile structure with a "T"-shaped intersection point 50 is formed by two girders with CF - profiles subject to bending running together at the intersection point, which, connect the force absorbing load points L1 and L2 (namely upper and lower door hinge 79a and 79b) as well as L3 (namely door lock 80). The girder a connects the upper hinge 79a with the lock 80 and the girder b connects the lower hinge 79b with the lock 80, wherein this latter girder b merges into the girder a at the intersection point 50 and continues on up to the lock 80 (thus defining a more complex structure shown as a + b). Cross-sectional views show:

- the arrangements of the CF - profiles 10.1, 10.4 of the girder a in a crimp 7;
- the arrangements of the CF - profiles 10.2, 10.3 of the girder b in the ribs 8; and
- the combination a + b with all four CF - profiles on the crimp 7.

[Para 47] This results in a strong and lightweight reinforcing structure, thus for example being capable of absorbing and supporting side crash loads L4, L5.

[Para 48] Fig. 12 illustrates an example of a structural component 82, which is assembled out of several parts, e.g., out of two shells, e.g., by welding or by gluing. Here a structural component 1 with an intersection point is joined to a further component 1.2, which forms a cover to an open crimp, so that both components 1 and 1.2 together form a closed, tubular, CF - reinforced profile cross-section with particularly high stiffness against torsion (as was explained above as a variant in Fig. 9). Two-part components of this kind are preferably welded together thermo-plastically. The shaping of the vertically oriented CF - profiles 10.2 and 10.3 in the side walls of the crimp 7 may, e.g., also comprise a flat part, which is adapted to the CF - profile 10.10 in the cover component 1.2. Behind these CF - profiles 10.2, 10.3 it would be possible for example to form a three-dimensional intersection point 50 with a vertical CF - profile 10.4 running through transversely.

[Para 49] It is instructive to discuss materials that are suitable for the structural components according to the invention

[Para 50] Fiber lengths. The LFT - mass 6 advantageously comprises an average fiber length of at least 3 mm, or more preferably in the range of of 5 - 15 mm. The continuous fiber (CF) reinforcement of the CF - profiles may consist of directed glass -, carbon - or aramide fibers in the thermoplastic matrix. Where the highest compressive strengths are needed, boron fibers or steel fibers may be employed.

[Para 51] Orientation and distribution of fibers. The CF - profiles 10 are capable of being mainly built-up out of UD (unidirectional) - layers (0°). It is also possible, however, to build up the CF-profiles from layers with differing fiber orientations, e.g., alternating with layers of 0°/90° or 0°/+45°/-45° fiber orientations. They could possibly also comprise a thin surface layer (e.g., 0.1 - 0.2 mm) made of pure thermoplastic material without any CF - fiber reinforcements.

[Para 52] Selection of polymers. For structural components as discussed herein, partially crystalline polymers such as polypropylene (PP), polyethylene-therephthalate (PET), polybutylene-therephthalate (PBT) or polyamide (PA) are well suited for the matrix of CF - profiles 10 and for the LFT - mass 6. One reason these polymers work well is that they are capable of comprising higher compressive strengths. It is also possible, however, to utilise amorphous polymers such as ABS (acrylonitrile butadiene styrene) or PC (polycarbonate).

[Para 53] Within the scope of this description, the following designations are used:

- 1 - Structural component
- 1.2 - Second part (two-shell)
- 4 - Inserts, inlays
- 6 - LFT - mass, form mass
- 7 - Crimp

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- 8 - Rib
- 10 - CF - profiles
- 22 - CF - profile shapings
- 32 - LFT - shapings
- 50 - Three-dimensional intersection point
- 54 - Positioning points
- 55 - Positioning shoulder
- 56 - Thick tensile - and compressive force zones in 10
- 57 - Thinner thrust zone
- 58 - Lock
- 59a, b - Axle holders
- 60 - Belt roller, belt connection, belt lock
- 61 - Head supports
- 72 - Single seat
- 74 - 2/3 Rear seat back
- 76 - Seat shell, cabin floor
- 78 - Car door
- 79 - Door hinges
- 80 - Door lock
- 82 - Two-shell structural component
- LFT - Long- fiber thermoplastic
- CF - Continuous fiber
- H1 - Upper main plane of 50
- H2 - Lower main plane of 50
- v - Distance between H1 and H2 (vertical)

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o L - Loads (K, M)

o F - Forces

o M - Moments

o UB - Force transmission at 50

o "T"-, "L"-, "X"-shaped intersection point

[Para 54] Those skilled in the art will have no difficulty at all in devising myriad obvious improvements and variations upon the invention, all of which are intended to be encompassed within the claims that follow.

What is claimed is:

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Fig. 1a a structural component according to the invention with a three-dimensional intersection point of several EF - profiles,¶
Fig. 1b, c cross-sections through a three-dimensional intersection point in different views, ¶
Fig. 2 a further example of a three-dimensional intersection point with variable profile cross-sections,¶
Fig. 3a an "X" - shaped intersection point,¶
Fig. 3b a "T" - shaped intersection point,¶
Fig. 3c an "L" - shaped intersection point,¶
Fig. 4 a "T" or "X" - shaped moment load-lever structure,¶
Fig. 5 an "L" - shaped moment load-lever structure,¶
Fig. 6 examples of three-dimensional profile shapings,¶
Fig. 7a, b two different cross-sectional shapes of an EF - profile in a rib,¶
Fig. 8a an arrangement of several EF - profiles

[Claim 1] A structural component made of long- fiber reinforced thermoplastic material with integrated continuous fiber - reinforcements, the component comprising:

- at least three individually integrated, shaped continuous fiber profiles,

- the at least three continuous-fiber profiles running together at a location,

- the at least three continuous-fiber profiles, at the location where they run together, defining a three-dimensionally developed intersection point,

- wherein at the intersection point at least a first continuous-fiber - profile lies in an upper plane of the intersection point, at least a second continuous-fiber profile lies a lower plane of the intersection point, and wherein at least a third continuous-fiber- profile with a vertical extension extends continuously between the first and second continuous-fiber – profiles;

- wherein the continuous-fiber - profiles are joined together by the long-fiber-reinforced thermoplastic material at the intersection point.

[Claim 2] The structural component of claim 1, characterised in that points of introduction of external force are formed by means of shapings of the long-fiber-reinforced thermoplastic, or by shapings of continuous-fiber profiles, or both.

[Claim 3] The structural component of claim 1, characterised in that the three-dimensional intersection points are developed as "X"-, "T"- or "L"-shaped.

[Claim 4] The structural component of claim 1, characterised in that the continuous-fiber - profiles are arranged in such a manner at the intersection point, that the continuous-fiber - profiles are capable of being inserted into a shaping tool for long-fiber-reinforced thermoplastic one after the other or together, and subsequently are capable of being pressed together with an introduced, molten long-fiber-reinforced thermoplastic - mass (6) in a press for long-fiber-reinforced thermoplastic in a single step and into a one-piece component.

[Claim 5] The structural component of claim 1, characterised in that the continuous-fiber- profiles are built up out of layers with differing fiber orientations.

[Claim 6] The structural component of claim 1, characterised in that the long-fiber-reinforced thermoplastic mass comprises an average fiber length of at least 3 mm.

[Claim 7] The structural component of claim 1, characterised in that the continuous-fiber - profiles comprise a continuous fiber reinforcement made out of glass -, carbon - or aramide fibers.

[Claim 8] The structural component of claim 1, characterised in that the thermoplastic material of the long-fiber-reinforced thermoplastic mass 6) and of the continuous-fiber - profiles consists of partially crystalline polymers selected from the set consisting of polypropylene, polyethylene-therephthalate, polybutylene-therephthalate and polyamide.

[Claim 9] The structural component of claim 1, characterised in that the continuous-fiber profiles comprise a three-dimensional profile shaping.

[Claim 10] The structural component of claim 1, characterised in that the continuous-fiber - profiles comprise a bend, a twist, a fold or a surface structuring in longitudinal direction.

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Deleted: a 2/3 rear seat back with

Deleted: ,¶
Fig. 8b the LFT - shaping of the component with the integrated EF - profiles,¶
Fig. 9 a single seat back with three-dimensional intersection points,¶
Fig. 10 an arrangement of EF - profiles

Deleted: seat shell or cabin floor,

Deleted: Fig. 11 a car door structure,¶
Fig. 12 an example of a two-shell component.¶

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[Claim 11] The structural component of claim 1, characterised in that the continuous-fiber- profiles comprise differing cross-sectional shapes.

[Claim 12] The structural component of claim 1, characterised in that shapings on the continuous-fiber - profiles and shapings of the long-fiber-reinforced thermoplastic mass are provided for force introductions and for force transmissions between the continuous-fiber- profiles and the long-fiber-reinforced thermoplastic - mass as well as to inserts.

[Claim 13] The structural component of claim 1, characterised in that a continuous-fiber - profile with a positioning shoulder, a thick tensile - and compressive force zone on top and underneath as well as a thinner thrust zone in between is formed, which is positioned in a rib or in a crimp wall of the structural component.

[Claim 14] The structural component of claim 1, characterised in that the continuous-fiber - profiles form a moment - load lever structure with a T-shaped or L-shaped three-dimensional intersection point.

[Claim 15] The structural component of claim 1, characterised in that the structural component forms a single seat back with a belt connection.

[Claim 16] The structural component of claim 1, characterised in that the structural component forms a two-thirds rear seat back with belt connection and lock.

[Claim 17] The structural component of claim 1, characterised in that the structural component forms a seat shell or a cabin floor.

[Claim 18] The structural component of claim 1, characterised in that the structural component forms a supporting structure of a car door with integrated side-crash protection.

[Claim 19] The structural component of claim 1, characterised in that the structural component is assembled out of at least two parts welded together.

[Claim 20] A method for the manufacturing of a structural component, the method comprising the steps of:

depositing several shaped continuous-fiber- profiles in a tool for shaping long-fiber-reinforced thermoplastic, n LFT - shaping tool,

the profiles deposited one after another or together;

subsequently introducing a long-fiber-reinforced thermoplastic mass;

in a single step, pressing the long-fiber-reinforced thermoplastic mass together with the continuous-fiber - profiles into a one-piece component.

ABSTRACT

[Para 55] A structural component (1) is made out of long- fiber reinforced thermoplastic material (LFT) with integrated continuous fiber (CF) - reinforcement. It includes at least three individually integrated, shaped CF - profiles (10), which form a three-dimensional intersection point (50). In this, at least one CF - profile (10) lies in an upper plane (H1), at least one CF-profile lies in a lower plane (H2) of the intersection point and at least one CF - profile extends continuously in a vertical direction (v) between these CF - profiles of the upper and of the lower main plane. The CF - profiles (10) are connected to one another by shapings (32) of the LFT - mass (6) at the intersection point in a force-transmitting manner. At several points loads (L) are exerted on the CF - profiles. Such three-dimensionally applied loads (L) are capable of being optimally supported.

DRAWINGS

Deleted: [1]

Deleted: Fig. 1a illustrates a

Deleted: according to the invention

Deleted: a three-dimensional (spatial) intersection point 50. The structural component comprises a shaping LFT - mass 6 (made of long-fibre reinforced thermoplastic) with a

Deleted: fibre

Deleted: comprising several individual, integrated EF

Deleted: with a defined shaping

Deleted: are shaped corresponding to the forces and loads to be absorbed and are arranged within the structural component individually precisely positioned. The

Deleted: comprises

Deleted: and a lower main

Deleted: ,

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Deleted: spacing

Deleted: . It is formed by at least three EF

Deleted: , which run together, resp., intersect with one another at

Deleted: intersection point,

Deleted: by the LFT - mass 6 joining all these

Deleted: . In this, at least one EF - profile respectively has to lie in the upper main plane H1 (here the profile

Deleted: .1) and one EF - profile in the lower main plane H2 (here the profile 10.4). And between the EF - profiles of the upper and

Deleted: lower main plane at least one further EF - profile, here the profiles 10.2 and 10.3, with a vertical orientation, resp., with an extension in vertical direction, has to pass through, in order to absorb a moment M2. All EF - profiles are joined together

Deleted: by the LFT – mass 6

Deleted:

Deleted: (UB) through corresponding shapings 32 of the LFT - mass, resp., through a mutual matching to one another with respect to shape of the EF - profiles and of the LFT - mass.

Deleted: In the example of Fig. 1a the EF - profiles 10.1, 10.4 are located in a crimp 7 and the EF - profiles 10.2 and 10.3 in ribs 8. In this manner forces F, moments M and loads L, which act on a structural component in differing directions, are absorbed by the EF - profiles and transmitted to the three-dimensional intersection point 50. It is in particular possible to transmit moments at the intersection point from one pr ... [1]

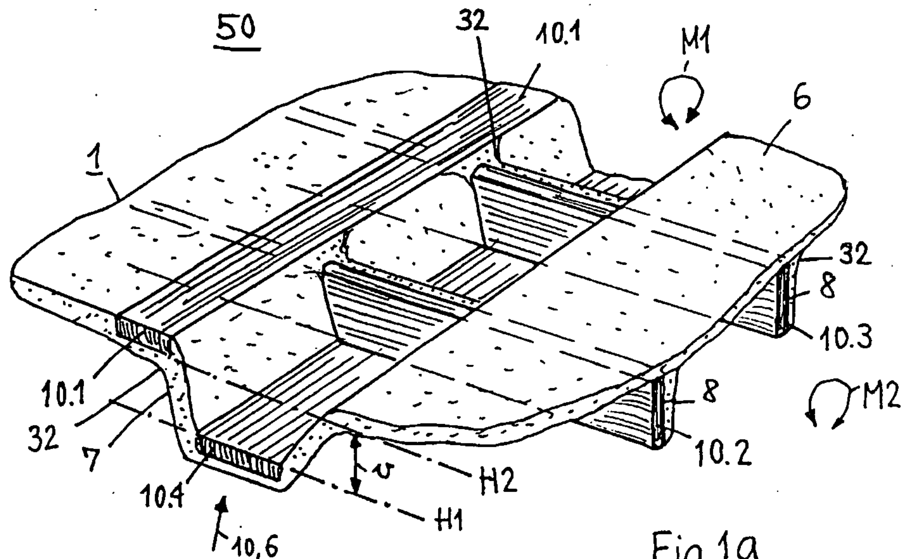

Fig.1a

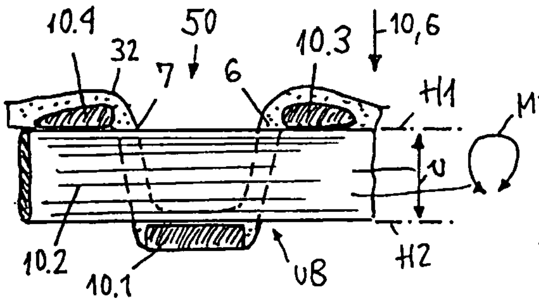

Fig. 1b

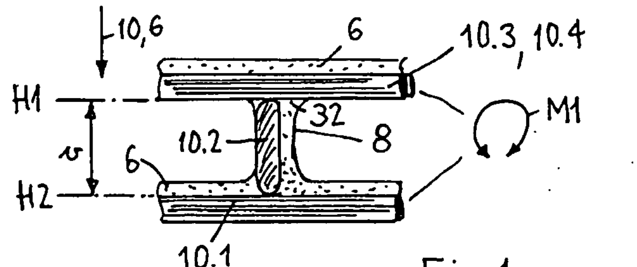

Fig. 1c

here is the following: First the EF - profile 10.1 is deposited in the lower main plane H2, then the EF - profiles 10.2 and 10.3 in the vertical intermediate zone v and thereupon the EF - profile 10.4 in the upper main plane H1 and subsequently the molten LFT - mass is placed on top and pressed together with the EF - profiles. This Fig. 1a illustrates a component, which following the pressing in the LFT - tool was turned over, so that in the figure H1 lies at the bottom and H2 lies on top. This way the EF - profiles are well visible. The direction, in which the EF - profiles 10 and the LFT - mass 6 are deposited, is indicated with an arrow.¶

¶

The Figs. 1b, 1c illustrate two sections through a further example of a three-dimensional intersection point 50 with two EF - profiles 10.3, 10.4 in the upper main plane H1, an EF - profile 10.1 in the lower main plane H2 as well as an EF - profile 10.2 in a rib 8 in the vertical zone v in between. The EF - profiles 10.1, 10.3, 10.4 are lying in a crimp 7, which intersects with the rib 8. The position of the component here is illustrated in the manner it lies in the LFT - tool. ¶

Fig. 1b illustrates the cross-section through the crimp 7, (which absorbs the moment M1) and Fig. 1c the cross-section through the rib 8, (which absorbs the moment M2). ¶

¶

For the optimum force transmission of EF - profiles 10 on to the LFT - mass 6 and from an EF - profile (10.1) through the LFT - mass on to other EF - profiles (10.3, 10.4), the LFT - mass comprises bonding shapings 32. By the arrangement of the EF - profiles and the shapings 32 of the LFT - mass the required force transmission UB is produced at the three-dimensional intersection point 50. ¶

¶

Fig. 2 illustrates a further example of a three-dimensional intersection point in a component, which is designed as a bent shell. The main planes H1 and H2 here form tangential planes at the intersection point 50. The given possible vertical spacing between H1 and H2 shall be relatively small for reasons of space. Then the EF - profile 10.2 intersecting with the flat EF - profiles 10.1 and 10.3 in the zone v at the intersection point is able to comprise a reduced height with, e.g., a square cross-section a and adjacent to the intersection point 50 once again change over into a flat, vertically oriented cross-section b. Important is the fact, that the EF - profiles in the v - zone comprise a vertical extension for the purpose of transmission of moments. I.e., the EF - profiles 10 in principle are able to comprise any three-dimensional shaping and position, which is optimally adapted to the load conditions and the force gradients. ¶

¶

The Figs. 3a, b, c schematically illustrate various possible types of three-dimensional intersection points. ... [2]

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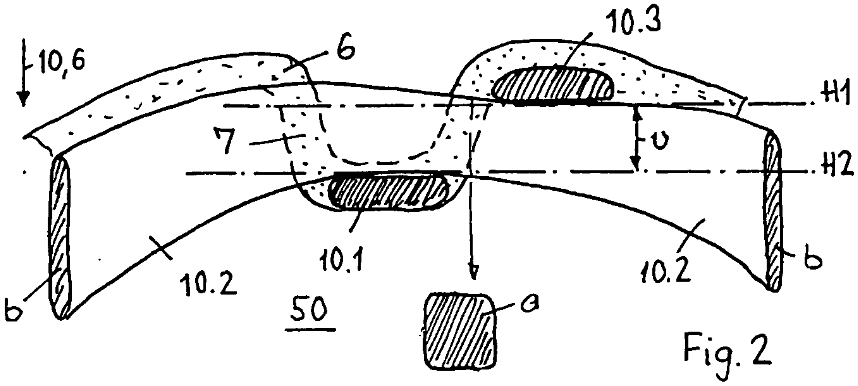

Fig. 2

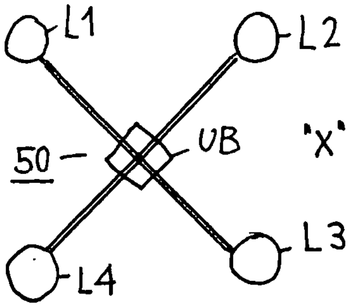

Fig. 3a

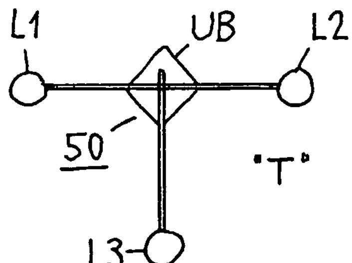

Fig. 3b

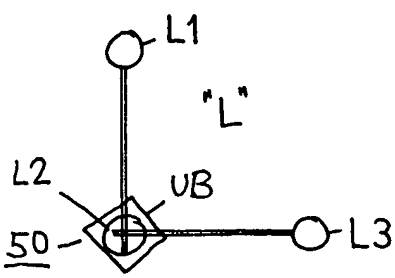

Fig. 3c

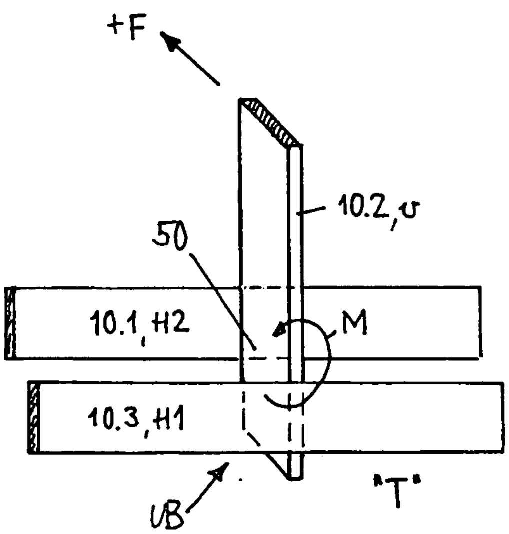

Fig. 4

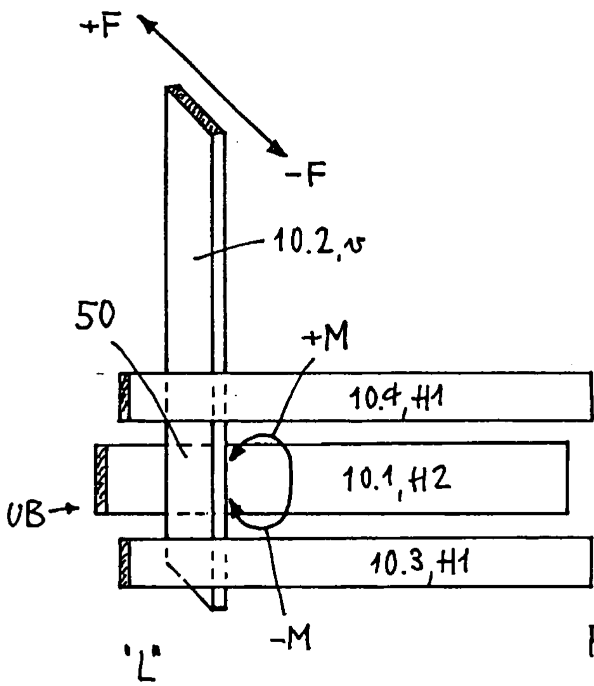

Fig. 5

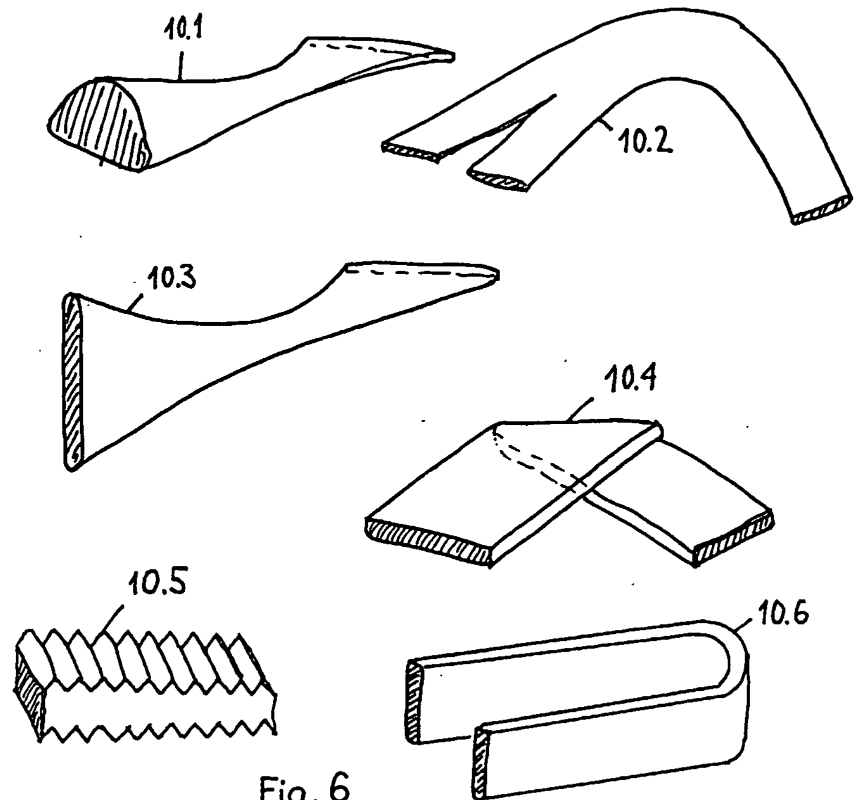

Fig. 6

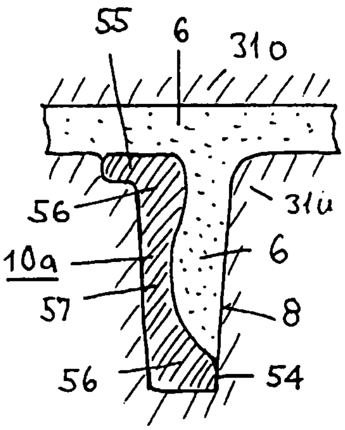

Fig. 7a

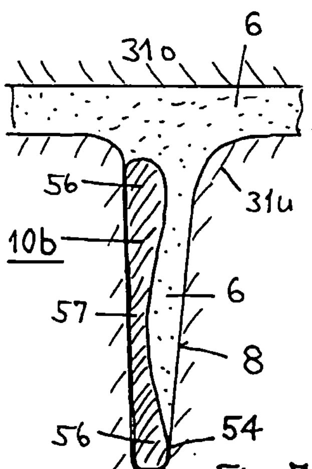

Fig. 7b

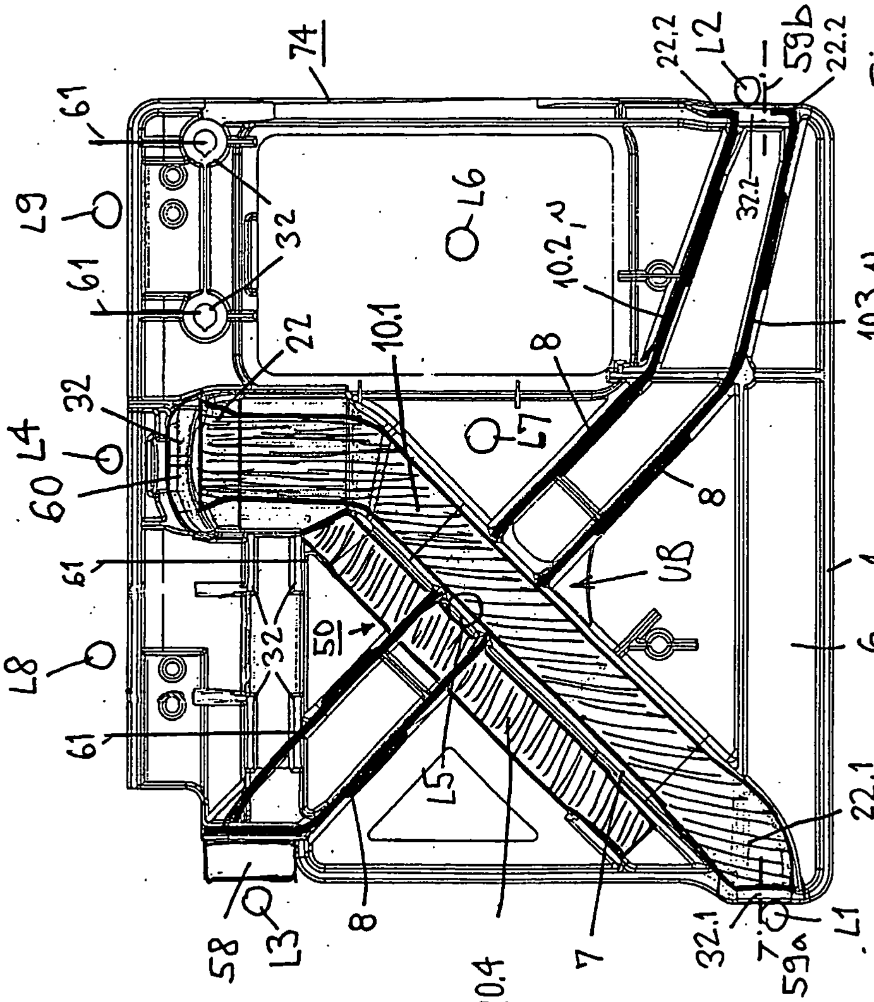
74
61
L9
32
61
32
22
10.1
L6
10.2,1
8
L7
8
L4
32
60
61
50
32
L8
61
UB
6
1
L5
10.4
7
8
58
L3
32.1
7'
59a
L1
22.1
22.2
L2
59b
22.2
32.2
10.3,1

Fig. 8a

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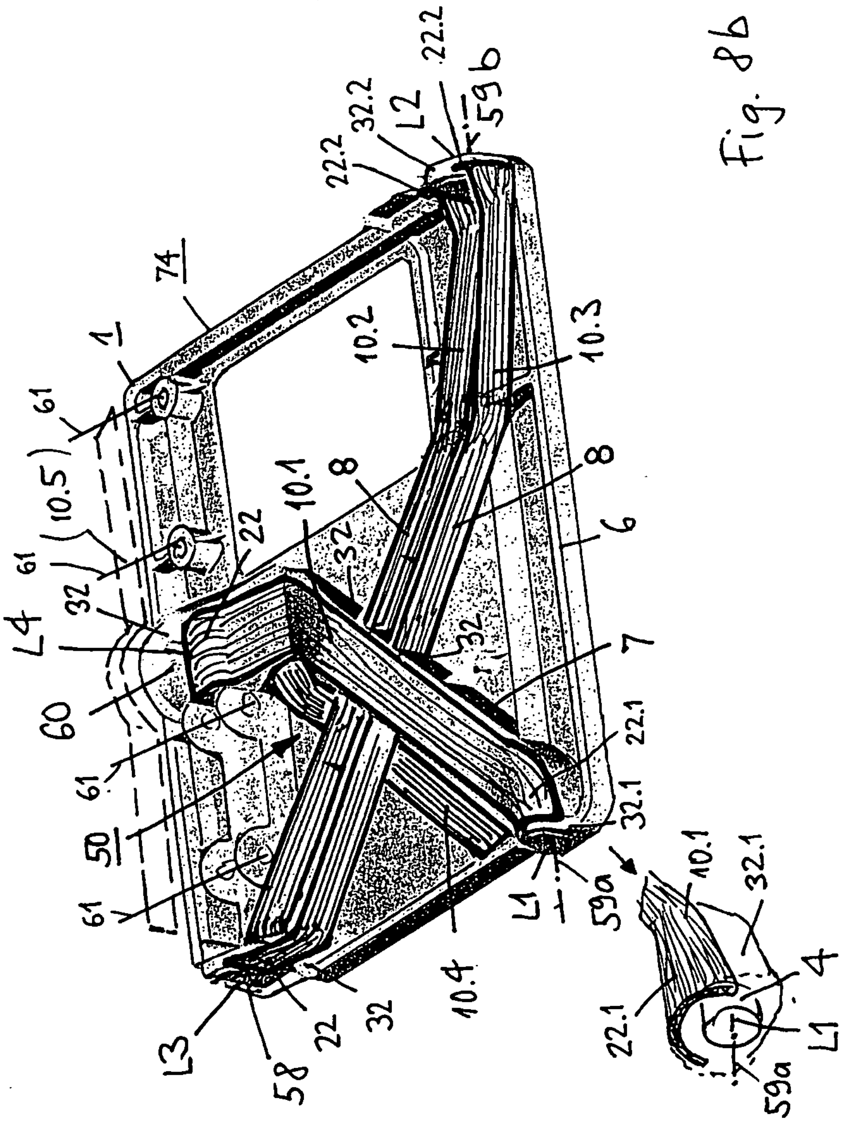

Fig. 8b

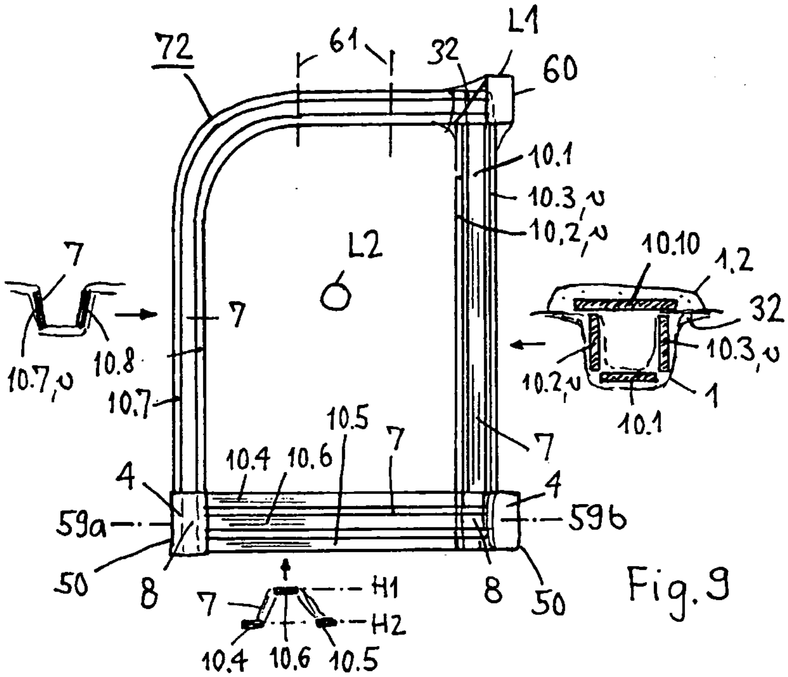
72
61
32
L1
60
10.1
10.3,v
10.2,v
L2
10.10
1.2
32
7
7
10.3,v
10.2,v
1
10.8
10.7,v
10.7
10.1
10.5
7
10.4
10.6
7
4
4
59a
59b
50
8
8
50
7
H1
H2
10.4
10.6
10.5

Fig. 9

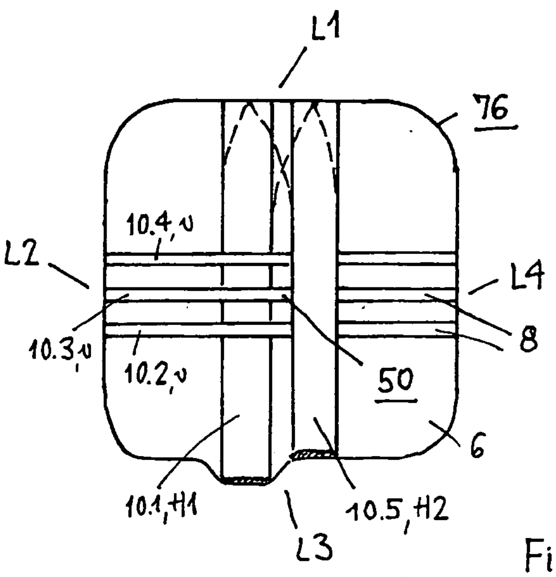
L1
76
10.4,v
L2
L4
10.3,v
8
10.2,v
50
6
10.1,H1
10.5,H2
L3

Fig. 10

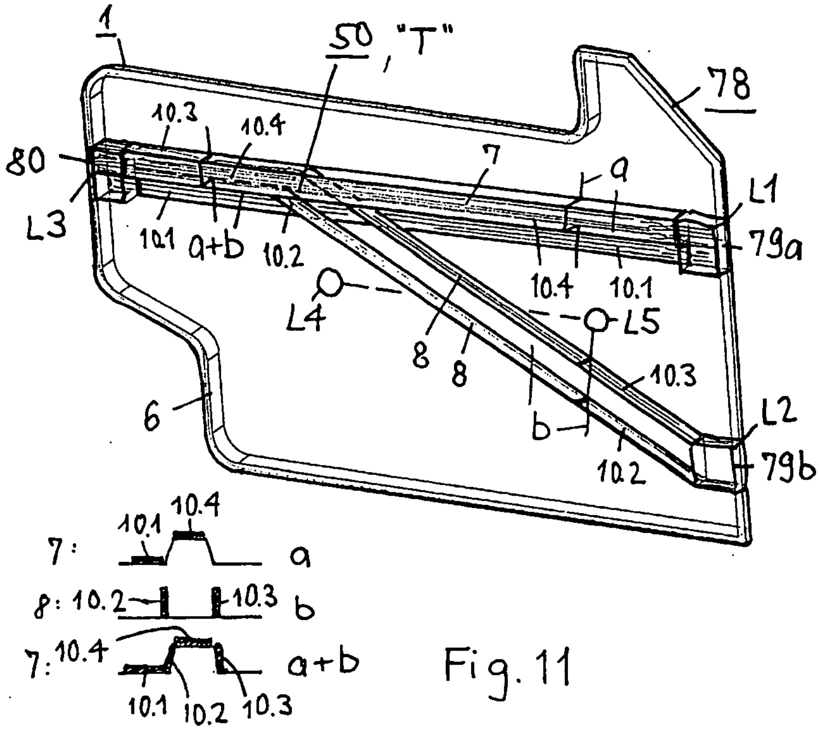
1
50 , "T"
78
10.3
10.4
80
7
a
L1
L3
10.1
a+b
10.2
10.4
10.1
79a
L4
L5
8
8
10.3
6
b
L2
10.2
79b
7:
10.1
10.4
a
8: 10.2
10.3
b
7: 10.4
a+b
10.1
10.2
10.3

Fig. 11

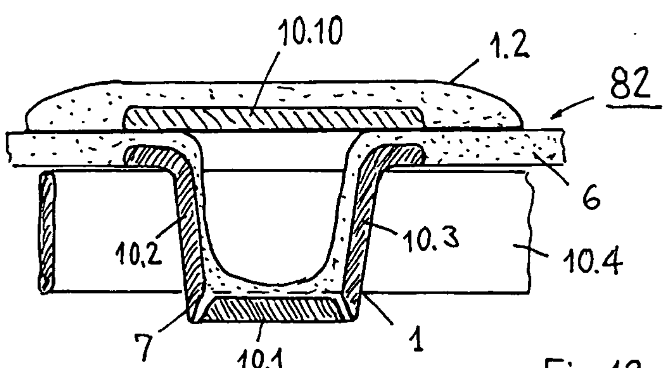
10.10
1.2
82
6
10.2
10.3
10.4
7
10.1
1

Fig.12

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Page 20: [1] Deleted **Myrtha Lanker** **3/14/2005 3:49 PM**

In the example of Fig. 1a the EF - profiles 10.1, 10.4 are located in a crimp 7 and the EF - profiles 10.2 and 10.3 in ribs 8. In this manner forces F, moments M and loads L, which act on a structural component in differing directions, are absorbed by the EF - profiles and transmitted to the three-dimensional intersection point 50. It is in particular possible to transmit moments at the intersection point from one profile pair to the other one. Here the EF - profiles 10.1 and 10.4 with the crimp 7 form a girder subject to bending and the profile pairs 10.2 and 10.3 in the rib structure 8 form a second girder subject to bending. With this, e.g., the moments M1 and M2 are absorbed and each respectively transmitted. An essential advantage of this arrangement of the EF - profiles according to the invention at the three-dimensional intersection point is the fact, that it consists of a single component and does not have to be assembled out of several components. For this purpose, according to the example the EF - profiles may be inserted into an LFT - shaping tool one after the other or together and subsequently together with an introduced, molten LFT - mass in a single step be pressed to become a one-part structural component in an LFT - press.

Page 21: [2] Deleted **Myrtha Lanker** **3/14/2005 3:49 PM**

The sequence of depositing here is the following: First the EF - profile 10.1 is deposited in the lower main plane H2, then the EF - profiles 10.2 and 10.3 in the vertical intermediate zone v and thereupon the EF - profile 10.4 in the upper main plane H1 and subsequently the molten LFT - mass is placed on top and pressed together with the EF - profiles. This Fig. 1a illustrates a component, which following the pressing in the LFT - tool was turned over, so that in the figure H1 lies at the bottom and H2 lies on top. This way the EF - profiles are well visible. The direction, in which the EF - profiles 10 and the LFT - mass 6 are deposited, is indicated with an arrow.

The Figs. 1b, 1c illustrate two sections through a further example of a three-dimensional intersection point 50 with two EF - profiles 10.3, 10.4 in the upper main plane H1, an EF - profile 10.1 in the lower main plane H2 as well as an EF - profile 10.2 in a rib 8 in the vertical zone v in between. The EF - profiles 10.1, 10.3, 10.4 are lying in a crimp 7, which intersects with the rib 8. The position of the component here is illustrated in the manner it lies in the LFT - tool.

Fig. 1b illustrates the cross-section through the crimp 7, (which absorbs the moment M1) and Fig. 1c the cross-section through the rib 8, (which absorbs the moment M2).

For the optimum force transmission of EF - profiles 10 on to the LFT - mass 6 and from an EF - profile (10.1) through the LFT - mass on to other EF - profiles (10.3, 10.4), the LFT - mass comprises bonding shapings 32. By the arrangement of the EF - profiles and the shapings 32 of the LFT - mass the required force transmission UB is produced at the three-dimensional intersection point 50.

Fig. 2 illustrates a further example of a three-dimensional intersection point in a component, which is designed as a bent shell. The main planes H1 and H2 here form tangential planes at the intersection point 50. The given possible vertical spacing between H1 and H2 shall be relatively small for reasons of space. Then the EF - profile 10.2 intersecting with the flat EF - profiles 10.1 and 10.3 in the zone v at the intersection point is able to comprise a reduced height with, e.g., a square cross-section a and adjacent to the intersection point 50 once again change over into a flat, vertically oriented cross-section b. Important is the fact, that the EF - profiles in the v - zone comprise a vertical extension for the purpose of transmission of moments. I.e., the EF - profiles 10 in principle are able to comprise any three-dimensional shaping and position, which is optimally adapted to the load conditions and the force gradients.

The Figs. 3a, b, c schematically illustrate various possible types of three-dimensional intersection points. Demanding structural components have to absorb and to transmit onwards several loads L, forces F and moments M, which attack at different points of the structural component and in differing directions. The three-dimensional intersection points 50 according to the invention for this purpose by means of corresponding arrangements of the EF - profiles in principle are able to be, for example, designed as "X"-, "T"- or "L"-shaped.

Fig. 3a in this context illustrates an "X"-shaped intersection point with load absorptions at the points L1 to L4 and with the force transmissions UB at the intersection point 50.

Fig. 3b illustrates a "T"-shaped intersection point with load absorptions at the points L1, L2, and L3 and with the force transmissions UB at the intersection point.

Fig. 3c illustrates an "L"-shaped intersection point with the load absorptions L1, L2, L3 and at the point L2 also with the force transmissions UB at the intersection point.

The Figs. 4, 5 illustrate examples of moment - load lever structures, which are formed by the arrangement of the EF - profiles with the intersection point 50.

Fig. 4 illustrates a moment - load lever structure with a "T"- or "X"-shaped intersection point 50. With it a force +F is supported as main load direction and absorbed by an EF - profile 10.2 as vertically oriented profile v, e.g., in a rib between two horizontal EF - profiles 10.1 in the lower main plane H2 and 10.3 in the upper main plane H1. The force F results in a moment M, which is supported by the EF - profiles 10.1, 10.3 in an appropriate shaping of the LFT - tool, e.g., in a crimp.

Fig. 5 illustrates an "L"-shaped moment - load lever structure, which as main load directions supports forces +F, -F (i.e., in both directions). It once again contains a vertically oriented profile 10.2 in the zone v, which is supported by three EF - profiles, e.g., at a crimp and in the main planes: the EF - profile 10.1 in H2 and the EF - profiles 10.3 and 10.4 in H1. With this, the moments +M, -M resulting from the forces +F, -F are supported and transmitted onwards.

With their shaping, the EF - profiles correspond to the differing functions and requirements at different points of an EF - profile, resp., component. They may comprise a three-dimensional shaping and for this purpose in longitudinal direction comprise a bend, a rotation, a twisting, a folding and/or a surface structuring and they may comprise varying, differing cross-sectional shapes.

Fig. 6 illustrates examples of possible shapings of this kind of the EF - profiles:

The EF - profile 10.1 manifests a roundish cross-section, which is flattened and spread out and there forms a large bonding surface to the surrounding LFT - mass (in the same manner as EF - profile 10.5).

The EF - profile 10.2 comprises a flat arc and is split in two at one end.

The EF - profile 10.3 comprises a twist from a flat to a vertically oriented cross-section.

The EF - profile 10.4 manifests a fold and

The EF - profile 10.5 a structured, zig-zag-shaped and through this enlarged surface.

The EF - profile 10.6 is bent into a "U"-shaped double rib. This could be utilised, e.g., in place of the two EF - profiles 10.2 and 10.3 in Fig. 1a.

The Figures 7a, 7b illustrate an example of an EF - profile 10, which over its length comprises differing cross-sectional shapes, this in adaptation to the forces to be transmitted and for the optimum bonding with the LFT - mass 6. The Figures in cross-sectional view illustrate an EF - profile 10a, 10b in a rib 8, e.g., corresponding to the profiles 10.2 or 10.3 of Fig. 8, at two different locations.

Fig. 7a illustrates a shaping 10a with a positioning shoulder 55 for fixing and holding the EF - profile in the required position - this especially during pressing, when the liquid LFT – mass 6 is pressed into the rib. On top and underneath the EF - profile respectively comprises a thicker zone 56 as tensile - and compressive zones (in longitudinal fibre direction) for the transmission of moments. Located in between is a thinner thrust zone 57 with a correspondingly thicker adjacent LFT - layer 6 and with a large bonding surface area and a particularly strong interface joint. With this, the shear resistance is increased by the adjacent LFT - layer 6 with isotropic fibre distribution (while the strength transverse to the fibre orientation in the EF - profiles 10 here is lower).

At another location according to Fig. 7b the profile cross-section 10b is changed corresponding to the force situation there: stretched, i.e., higher and narrower and without a positioning shoulder.
For the secure and accurate positioning and fixing of the EF - profiles, this also during the pressing with the LFT - mass, further positioning points 54 may be developed on the EF - profiles, which correspond to the shaping of the LFT - tool 31o (top) and 31u (bottom). Here the positioning point 54 serves for the accurate positioning below in the rib 8. Positioning points can also be arranged suitably distributed in the longitudinal direction of the EF - profiles.

In an analogous manner, profile shapes of this kind may also be positioned and fixed on crimped walls, e.g. on the two side walls of a crimp 7 instead of the two EF - profiles (10.2., 10.3) in two separate ribs 8, as it is illustrated in the following example of Fig. 8. Instead of the examples 7a, 7b, it is also possible to design the cross-sections of EF - profiles, for example, as "L"- or "Z"-shaped, depending on the application.

Figs. 8a, b illustrate the example of a complex structural component with a three-dimensional intersection point in the form of a two third (2/3) rear seat back 74 with a central seat belt connection 60 for the middle seat and a lock 58 and with several demanding load introductions for different load cases (crash loads). Fig. 8a in plan projection illustrates the arrangement of the EF - profiles in the component and Fig. 8b in a perspective view the LFT - mass 6 and drawn in it the integrated EF - profiles 10.1 to 10.4. This example illustrates the load-optimised shaping of the EF - profiles themselves as well as the load-optimised arrangement to form a structure with a corresponding shaping of the LFT - mass 6 and with an optimum bonding strength between the EF - profiles carrying the main loads (with directed continuous fibres) and the complementing LFT - mass (with undirected long fibres).

Here four main load carrying points L1 to L4 result from:

the loads L1, L2 on the axle holders 59a, 59b, around which the rear seat back 74 is capable of being swivelled,

the load L3 on the lock 58, for fixing the rear seat back in its normal position and

the load L4 on the belt lock, resp., belt roller 60 for the central belt of the middle seat.

With this structural component the following load cases (with the further loads L5 to L9) are covered:

Front - and rear collision

Securing of any goods loaded

Belt anchoring

Head support / head rest anchoring.

For the receiving and transferring of all loads and forces the intersecting EF - profiles together with the joining force-transmitting shapings of the LFT - mass form a spatial, three-dimensional intersection structure 50. Here the EF - profiles respectively in pairs in the LFT – shapings form a moment-transmitting girder subject to bending:

The EF - profiles 10.1 and 10.4 in a crimp 7 of the LFT – mass form a girder subject to bending between the loads L1 and L4

and the EF - profiles 10.2 and 10.3 in the ribs 8 of the LFT - mass a girder subject to bending between the loads L2 and L3.

Through the three-dimensional intersection point 50, in this the load L4 on the belt roller 60 and also other loads, which act on the girder subject to bending 10.1 / 10.4, is also supported on the other girder subject to bending 10.2/ 10.3 (and vice-versa).

The main forces, resp., loads L1 to L4 are received by means of force introduction points:

through shapings 22 and 32 of the EF - profile ends and of the LFT - mass for receiving the external forces with or without inserts 4.

In doing so, the inserts 4 prior to the pressing operation are able to be inserted into the LFT - tool and then pressed together with the EF - profiles and the LFT mass

or else it is also possible to fit them into the component later on.

Here the EF - profile 10.1 comprises an arc-shaped widening 22 and an adapted widening 32.1 for receiving a metallic insert 4 at the axle bearing 59a. The other axle holder receptacle 59b is formed by shapings 22.2 of the EF - profiles 10.2 and 10.3 and by adapted joining shapings 32.2 of the LFT - mass. These profile ends 22.2 are bent over and in this manner anchored in the LFT - mass for the purpose of increasing the tensile strength. The lock 58 is bolted on to a lock plate on the EF - profile 10.3 and supported by the EF - profile 10.2. The belt roller 60 is supported by shapings 22 of the EF - profiles 10.1 and 10.4 and by LFT - shapings 32.

The smaller loads L8, L9 of head supports 61 here are absorbed through LFT - shapings 32. For reinforcement, however, it would also be possible to integrate an additional EF - profile 10.5 deposited transversely (in some zones oriented flat or vertically).

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The depositing sequence of the EF - profiles into the LFT - tool is as follows:
First the EF - profile 10.1 (in H2), thereupon the EF - profiles 10.2 and 10.3 and subsequently the EF - profile 10.4 (in H1). Then the liquid LFT - mass 6 is introduced and the complete tool pressed as a single shell and as a single part in a single step. (The illustrated structural component is lying in the LFT - shaping tool upside down, i.e., there H2 is at the bottom and H1 is on top. Fig. 8 illustrates the rear side of the rear seat back 74.)
In this example also the three-dimensional profile shaping is evident in many variants.

The shapings in the structural component may comprise special shapings 22 for force transmissions and for the direct absorption of external loads, resp., for the receiving of inserts 4 (mounting parts), at which external loads are introduced into the component. The shaping of the surrounding LFT - mass 6 is also selected to match the shaping of the EF - profiles 10. Shapings of force transfer points (of forces and moments) inside a component (e.g., from an EF - profile through the LFT - mass on to other EF - profiles) can be formed both as shapings 22 of the EF - profiles as well as shapings 32 of the LFT - mass.
In general as balanced as possible, continuous transitions are formed for the reduction of steps in strength and rigidity between the EF - profiles and the LFT - mass.

Fig. 9 illustrates a single seat back 72 with a belt connection 60 and head supports 61, in the case of which similar loads and load cases occur as in the example of Fig. 8, here with the main loads L1 at the belt connection 60 and L2 with the weight of the passenger. All loads, however, have to be supported by the axle holders, which are capable of being fixed 59b, and possibly also 59a, around which the seat back is adjusted as capable of being swivelled. In this, the locking may be present on both sides on 59b and 59a or frequently only on one side on 59b. In the latter case, a profile support formed out of EF - profiles between the lock 59b and the belt connection 60 has to be designed to be particularly strong with an enhanced stiffness against torsion. For this purpose here a closed hollow profile cross-section can be formed (in analogy to Fig. 12), for example,

with three EF - profiles 10.1, 10.2, 10.3 in a crimp 7 of the structural component 1 and on it a separate cover component 1.2 with an EF - profile 10.10 may be thermoplastically welded on.

The profile support between the axle holders and the locks 59a and 59b here comprises the EF - profiles 10.4, 10.5, 10.6 in the main planes H1, H2 on a crimp 7. The profile support between the axle holder 59a and the belt connection (belt roller) 60 is curved and comprises two vertical EF - profiles 10.7, 10.8, e.g., in the side walls of a crimp 7. Here two three-dimensional intersection points 50 are formed on the axle holders 59a and 59b. In doing so, all EF - profiles are integrated into crimps here, wherein at the three-dimensional intersection points of the EF - profiles the crimps locally become ribs, so that there an intersection point between a rib 8 and a crimp 7 is always produced and so that all EF - profiles are capable of being deposited in a single step and the structural component 1 is able to be pressed in a single step and in a single piece. It goes without saying, that other arrangements of EF - profiles in ribs and in crimps are also able to be combined as per requirement.

Fig. 10 illustrates an arrangement of EF - profiles with a three-dimensional intersection point 50, which is designed as a seat shell 76 or as a cabin floor, e.g., of a lift cabin. In order here to implement a shell with a relatively small thickness, i.e., with a small vertical spacing v between the main planes H1, H2, in this case three vertical EF - profiles 10.2, 10.3, 10.4, are integrated into a rib structure, which intersect with two EF - profiles 10.1, 10.5 in the main planes H1, H2. At a free end L1 of a seat shell, the EF - profiles 10.1 und 10.5 may also run together and may be directly joined together there in a plane manner. With the loads L2 – L4 (also L1) this structure is supported.

Fig. 11 illustrates an example of a structural component, which forms a supporting structure of a car door 78 with integrated side crash protection. The EF - profile structure with a "T"-shaped intersection point 50 is formed by two girders with EF - profiles subject to bending running together at the intersection point, which, connect the force absorbing load points L1 and L2 = upper and lower door hinge 79a and 79b as well as L3

= door lock 80. The girder subject to bending a connects the upper hinge 79a with the lock 80 and the girder subject to bending b the lower hinge 79b with the lock 80, wherein this latter one merges into the girder subject to bending a at the intersection point 50 and continues on up to the lock 80 (a + b). The arrangements of the EF - profiles 10.1, 10.4 of the girder subject to bending a in a crimp 7 and of the EF - profiles 10.2, 10.3 of the girder subject to bending b in the ribs 8 as well as the combination a + b with all four EF - profiles on the crimp 7 are depicted in cross-sectional views. This results in a strong and lightweight reinforcing structure, in order to, e.g., also be capable of absorbing and supporting side crash loads L4, L5.

Fig. 12 illustrates an example of a structural component 82, which is assembled out of several parts, e.g., out of two shells, e.g., by welding or by gluing. Here a structural component 1 with an intersection point is joined to a further component 1.2, which forms a cover to an open crimp, so that both components 1 and 1.2 together form a closed, tubular, EF - reinforced profile cross-section with particularly high stiffness against torsion (as is explained as a variant in Fig. 9). Two-part components of this kind are in preference welded together thermo-plastically. The shaping of the vertically oriented EF - profiles 10.2 and 10.3 in the side walls of the crimp 7 may, e.g., also comprise a flat part, which is adapted to the EF - profile 10.10 in the cover component 1.2. Behind these EF - profiles 10.2, 10.3 it would be possible, e.g., to form a three-dimensional intersection point 50 with a vertical EF - profile 10.4 running through transversely.

The following materials are suitable for the structural components according to the invention: The LFT - mass 6 advantageously comprises an average fibre length of at least 3 mm, even better of 5 – 15 mm. The continuous fibre (EF) reinforcement of the EF - profiles may consist of directed glass -, carbon - or aramide fibres in the thermoplastic matrix (wherein in special cases also boron fibres for the highest compressive strengths or steel fibres would not be excluded).

The EF - profiles 10 are capable of being mainly built-up out of UD (unidirectional) - layers (0°), also, however out of layers with differing fibre orientations, e.g., alternating

with layers of 0°/90° or 0°/+45°/-45° fibre orientations. They could possibly also comprise a thin surface layer (e.g., 0.1 – 0.2 mm) made of pure thermoplastic material without any EF - fibre reinforcements.

Especially suitable for structural components are partially crystalline polymers such as polypropylene (PP), polyethylene-therephtalate (PET), polybutylene-therephtalate (PBT) or polyamide (PA) as matrix of EF - profiles 10 and of LFT - mass 6, e.g., because these are capable of comprising higher compressive strengths. It is also possible, however, to utilise amorphous polymers such as ABS or PC.

Within the scope of this description, the following designations are used:

1	Structural component
1.2	Second part (two-shell)
4	***Inserts, inlays***
6	LFT - mass, form mass
7	Crimp
8	Rib
10	EF - profiles
22	***EF - profile shapings***
32	LFT - shapings
50	Three-dimensional intersection point
54	Positioning points
55	Positioning shoulder
56	Thick tensile - and compressive force zones in 10
57	Thinner thrust zone
58	Lock
59a, b	Axle holders
60	Belt roller, belt connection, belt lock
61	Head supports
72	Single seat

74	2/3 Rear seat back
76	Seat shell, cabin floor
78	Car door
79	Door hinges
80	Door lock
82	Two-shell structural component
LFT	Long-fibre thermoplastic
EF	Continuous fibre
H1	Upper main plane of 50
H2	Lower main plane of 50
v	Distance between H1 and H2 (vertical)
L	Loads (K, M)
F	Forces
M	Moments
UB	Force transmission at 50

"T"-, "L"-, "X"-shaped intersection point

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Claims

1. Structural component (1) made of long-fibre reinforced thermoplastic material (LFT) with integrated continuous fibre (EF) - reinforcements, characterised by

- at least three individually integrated, shaped continuous fibre (EF) - profiles (10),
- which run together at an intersection point,
- and which form a spatial (three-dimensionally developed) intersection point (50),
- wherein at the intersection point at least one EF - profile (10) respectively lies in an upper and in a lower main plane (H1, H2) of the intersection point and one EF - profile with vertical extension (v) extends continuously between these EF - profiles of the upper and the lower main plane

- and wherein the EF - profiles (10) are joined together by the LFT - mass (6) at the intersection point (50) in a force-transmitting manner
- by corresponding shapings (32) of the LFT - mass
- and wherein several forces (F) or moments (M) are capable of being supported on the EF - profiles (10) at several points for the absorption of external loads (L).

2. Structural component according to claim 1, characterised in that external force introductions (L) are formed by means of LFT - shapings (32) and/or with corresponding EF - profile shapings (22).

3. Structural component according to claim 1, characterised in that the three-dimensional intersection points (50) are developed as "X"-, "T"- or "L"-shaped.

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4. Structural component according to claim 1, characterised in that the EF - profiles are arranged in such a manner at the intersection point (50), that the EF - profiles (10) are capable of being inserted into an LFT - shaping tool one after the other or together and subsequently are capable of being pressed together with an introduced, molten LFT - mass (6) in an LFT - press in a single step and into a one-piece component.

5. Structural component according to claim 1, characterised in that the EF - profiles (10) are built up out of layers with differing fibre orientations.

6. Structural component according to claim 1, characterised in that the LFT - mass (6) comprises an average fibre length of at least 3 mm.

7. Structural component according to claim 1, characterised in that the EF - profiles (10) comprise a continuous fibre reinforcement (EF) made out of glass -, carbon - or aramide fibres.

8. Structural component according to claim 1, characterised in that the thermoplastic material of the LFT - mass (6) and of the EF - profiles (10) consists of partially crystalline polymers such as PP, PET, PBT, PA.

9. Structural component according to claim 1, characterised in that the EF - profiles (10) comprise a three-dimensional profile shaping.

10. Structural component according to claim 1, characterised in that the EF - profiles (10.1 – 10.6) comprise a bend, a twist, a fold and/or a surface structuring in longitudinal direction.

11. Structural component according to claim 1, characterised in that the EF - profiles (10) comprise differing cross-sectional shapes.

12. Structural component according to claim 1, characterised in that shapings on the EF - profiles (22) and shapings (32) of the LFT - mass for force introductions and for force transmissions between the EF - profiles (10) and the LFT - mass (6) as well as to inserts (4) are provided.

13. Structural component according to claim 1, characterised in that an EF - profile (10) with a positioning shoulder (55), a thick tensile - and compressive force zone (56) on top and underneath as well as a thinner thrust zone (57) in between is formed, which is positioned in a rib (8) or in a crimp wall (7) of the structural component.

14. Structural component according to claim 1, characterised in that the EF - profiles (10) form a “moment - load lever structure” with a "T"-shaped or "L"-shaped three-dimensional intersection point.

15. Structural component according to claim 1, characterised in that it forms a single seat back (72) with a belt connection (60).

16. Structural component according to claim 1, characterised in that it forms a two-thirds rear seat back (74) with belt connection (60) and lock (58).

17. Structural component according to claim 1, characterised in that it forms a seat shell (76) or a cabin floor.

18. Structural component according to claim 1, characterised in that it forms a supporting structure of a car door (78) with integrated side-crash protection.

19. Structural component according to claim 1, characterised in that is assembled out of several parts (e.g., two-shell 1, 1.2) (82).

20. Method for the manufacturing of a structural component according to claim 1, characterised in that
several shaped EF - profiles (10) are deposited in an LFT - shaping tool one after another or together and for the formation of a three-dimensional intersection point (50) there are positioned in a given position and subsequently an LFT - mass (6) is introduced and together with the EF - profiles (10) is pressed into a one-piece component in a single step.

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Abstract

The structural component (1) made out of long-fibre reinforced thermoplastic material (LFT) with integrated continuous fibre (EF) - reinforcements comprises at least three individually integrated, shaped EF - profiles (10), which form a three-dimensional intersection point (50). In this, at least one EF - profile (10) respectively lies in an upper and in a lower main plane (H1, H2) of the intersection point and one EF - profile extends continuously in vertical direction (v) between these EF - profiles of the upper and of the lower main plane. The EF - profiles (10) are connected to one another by shapings (32) of the LFT - mass (6) at the intersection point in a force-transmitting manner. At several points loads (L) are exerted on the EF - profiles. With this, three-dimensionally applied loads (L) are capable of being optimally supported.

(Fig. 1a)